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AN ELECTRONIC FIRE WEATHER STATION

By

Clive M. Countryman
John R. Murray
Charles W. Philpot

ABSTRACT: A new electronic fire weather station automatically records wet and dry bulb temperatures, radiation, windspeed and direction, standard fuel stick moisture content, and fine fuel temperature at 6- or 30-minute intervals for one week without attention.

New studies dealing with the effect of weather variables on fire behavior require the continuous sampling of weather for long periods over large areas. The most economical way to do this is through some automatic system that will require only intermittent human attention. To that end, we have developed an electronic fire weather station (fig. 1) that will record several variables at pre-set intervals automatically for a week. It is portable, reasonably accurate and economical, and has low power requirements.

The station consists of sensing elements, a programmer, and a recorder. It can be placed in a permanent shelter or, if greater mobility is desired, mounted on a small trailer. Although any 24-volt D.C. power supply can be used, we have found that an 11-ampere-hour wet cell battery is the most economical and dependable.

Wind speed is measured by means of a standard 3-cup Friez anemometer. Contact closures are accumulated in the programmer and reset after each readout. This gives average wind velocity for the recording interval. The anemometer is mounted on a cross arm attached to a telescoping aluminum pole.

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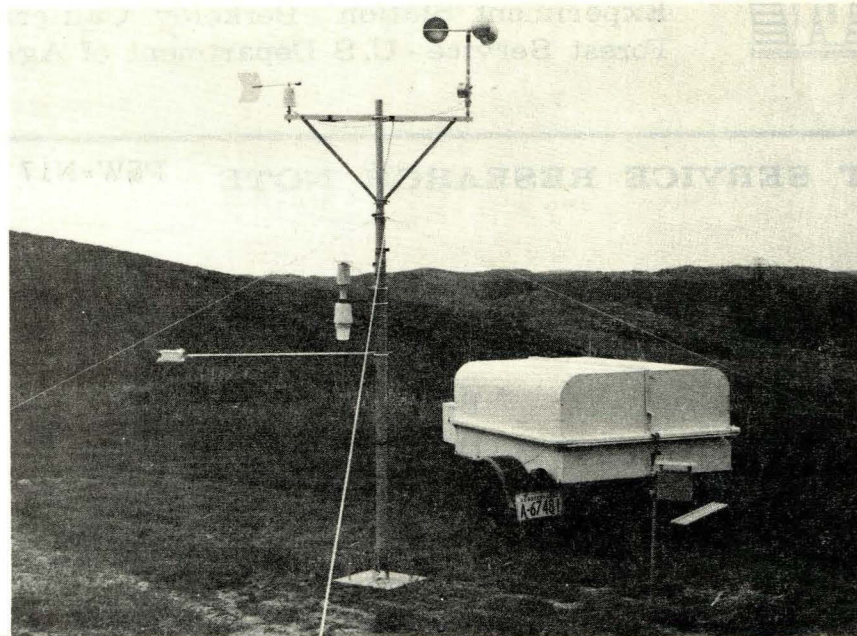


Figure 1.--Electronic fire weather station automatically gathers continuous weather data for one week without attention.

Wind direction is measured by a transmitter vane of our own design (fig. 2). It consists of a horizontal shaft with a plastic vane and a brass counter-balance connected to a vertical shaft supported by two sets of ball bearings. A set of brushes is attached to the vertical shaft. The brushes move over a fixed printed circuit board and add increments of resistance for each 45° clockwise from north. A readout of a given resistance is then identified with a wind direction. The vane transmits eight directions. It is mounted on the cross arm at the end opposite the anemometer.

Net radiation is obtained by the use of a radiometer (fig. 3) based on the design suggested by Suomi and Kuhn.^{1/} It consists of two 1-inch square, flat, (Parson's Optical) black aluminum plates separated by 2 inches of styrofoam insulation. A thermistor is mounted on the back of each plate and two sheets of 0.001-inch polyethelene are used to protect the plates from moisture. Top and bottom plate temperatures are recorded separately and the difference taken to obtain the net radiation. The unit is built into a small aluminum case attached to a 3-foot piece of aluminum tubing. The tubing is connected to the anemometer pole.

^{1/} Suomi, V. E. and Kuhn, P. M. An economical net radiometer. Tellus X. pp. 160-163, illus. 1958.

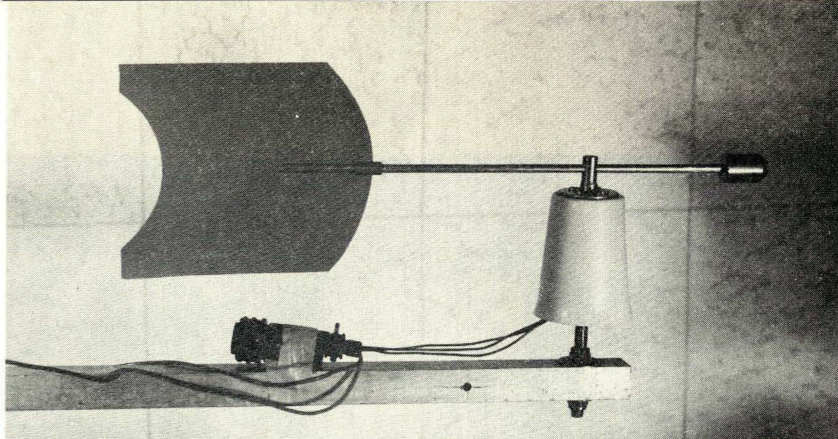


Figure 2.--Transmitter vane electronically transmits eight wind directions to the programmer-recorder.

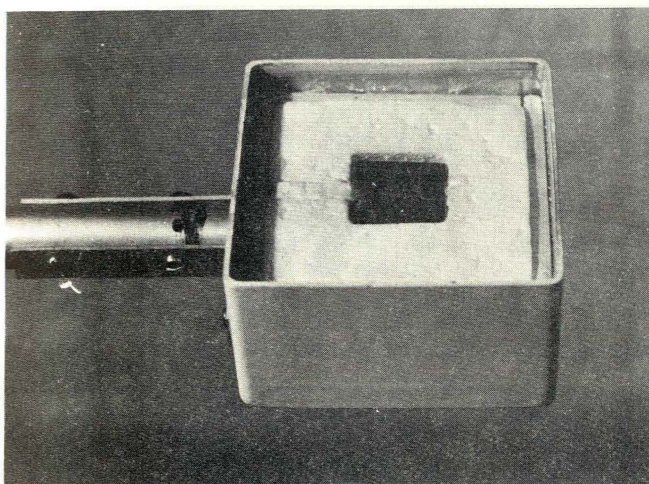


Figure 3.--Radiometer measures top and bottom plate temperatures to give net radiation.

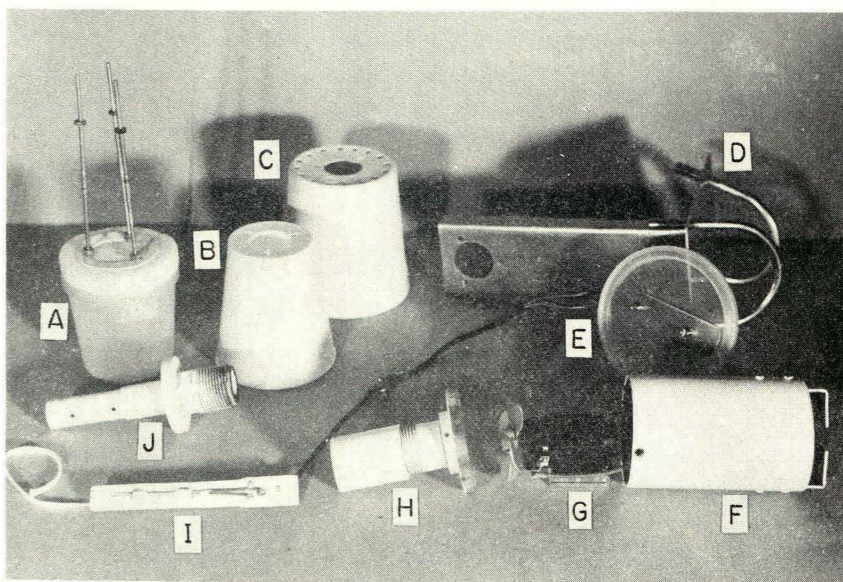


Figure 4.--Electronic psychrometer measures wet and dry bulb temperatures. Disassembled view shows: A reservoir, B polystyrene insulator, C polystyrene shade, D mounting bracket, E rain cover, F fan housing, G fan & motor, H tube connecting aspirator to psychrometer, I thermistor & wicking, and J air intake tube.

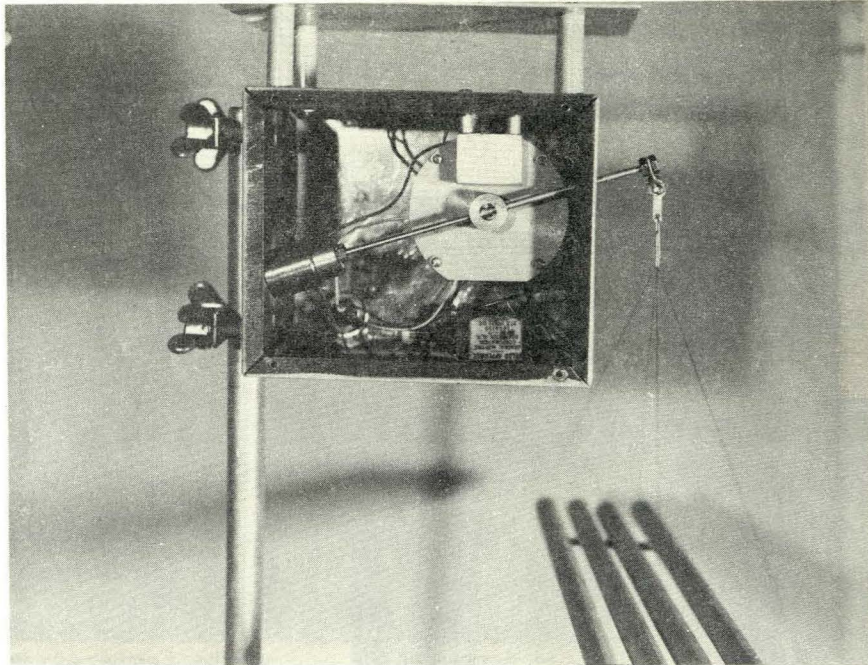


Figure 5.--Electronic fuel moisture balance weighs moisture content of standard fuel sticks. A plate has been removed to show balance arm, potentiometer, and dither motor (rear).

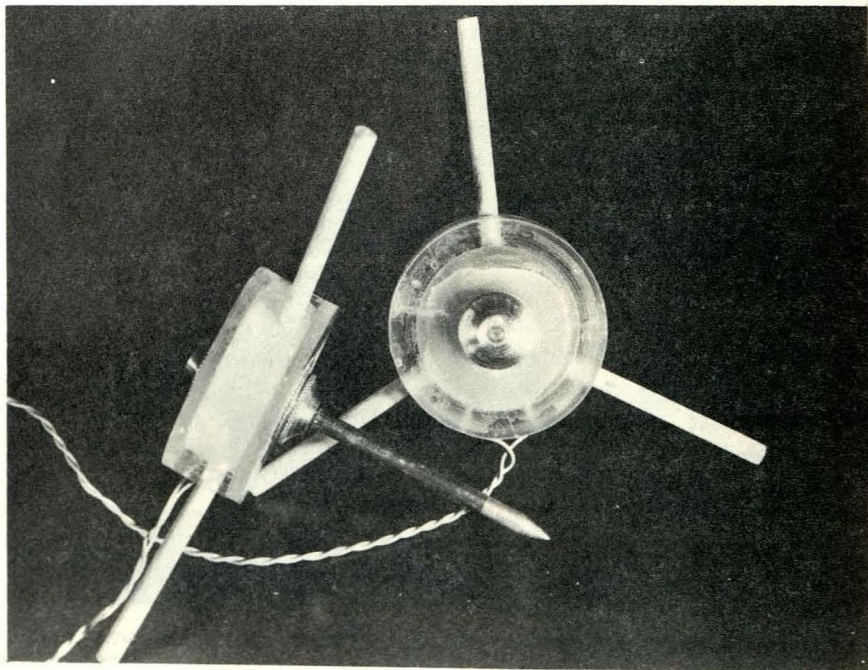


Figure 6.--Fuel temperature sensor has wood dowels simulating fine fuel.

Wet and dry bulb temperatures are measured by an electronic psychrometer of our own design (fig. 4). This unit consists of precision thermistors, fan, reservoir, and shade. One of the thermistors is kept moist by means of wicking from the reservoir. The fan draws air past the sensing elements 20 seconds before the temperature data is recorded. The thermistors are protected from radiation by styrene foam and a polystyrene shield.

Fuel stick moisture is measured by an electronic fuel-moisture balance of our own design (fig. 5). This instrument has a counter-weighted balance arm which is connected to a variable ultra low torque potentiometer. As the standard fuel sticks collect moisture, the arm depresses, rotating the potentiometer and thus changing the resistance in the potentiometer. The change is recorded in millivolts. A small dither motor vibrates the unit just before a reading is taken in order to overcome any effects of friction. The balance is equipped with an aluminum sun shade to reduce any drastic temperature change.

Fine-fuel² temperature is measured by the sensor described in a previous article²; that is, three thermistors placed, one each, in wood dowels and sealed in a styrene ring (fig. 6). The sensor is inserted into the ground by means of a brass spike.

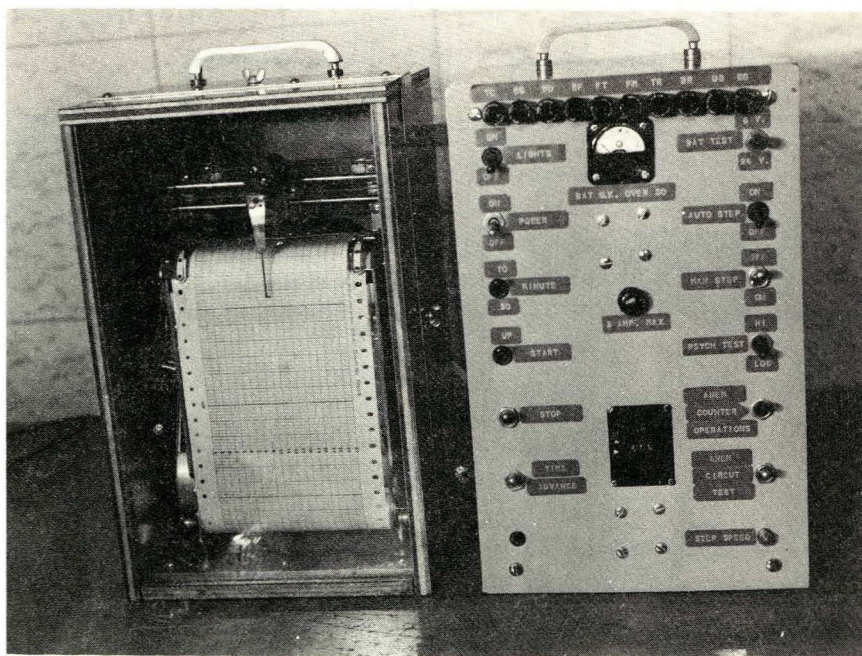


Figure 7.--Programmer (right) and recorder collect and record data at pre-set intervals.

² Murray, John R., and Philpot, Charles W. The fuel temperature counter. U.S. Forest Serv. Res. Note PSW-10, 5 pp., illus. Pacific SW. Forest & Range Expt. Sta., Berkeley, Calif. 1963.

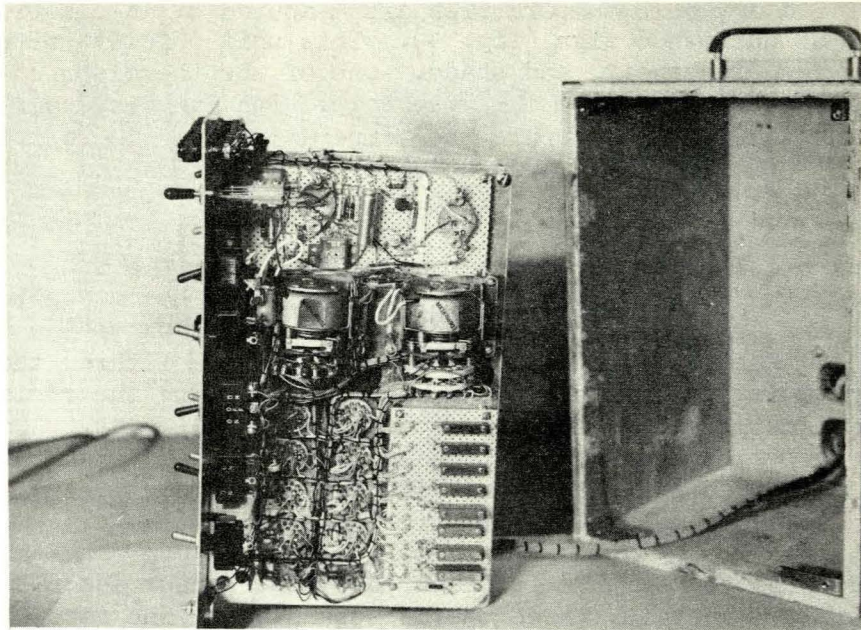


Figure 8.--Open view of programmer showing solid state timer, sequencer stepping switch, anemometer stepping switch, and bridge.

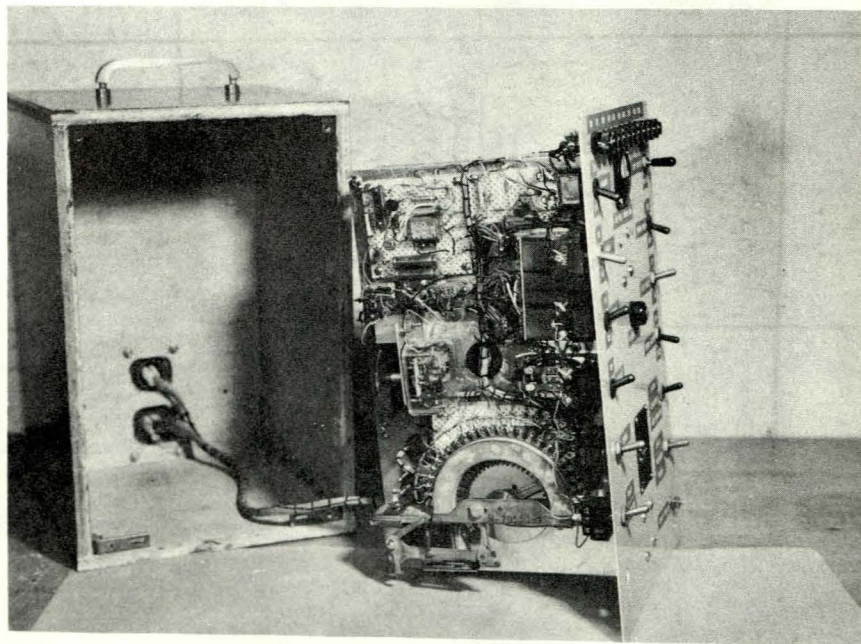


Figure 9.--Open view of programmer showing 60-second fail safe timer, clock, and clock stepping switch.

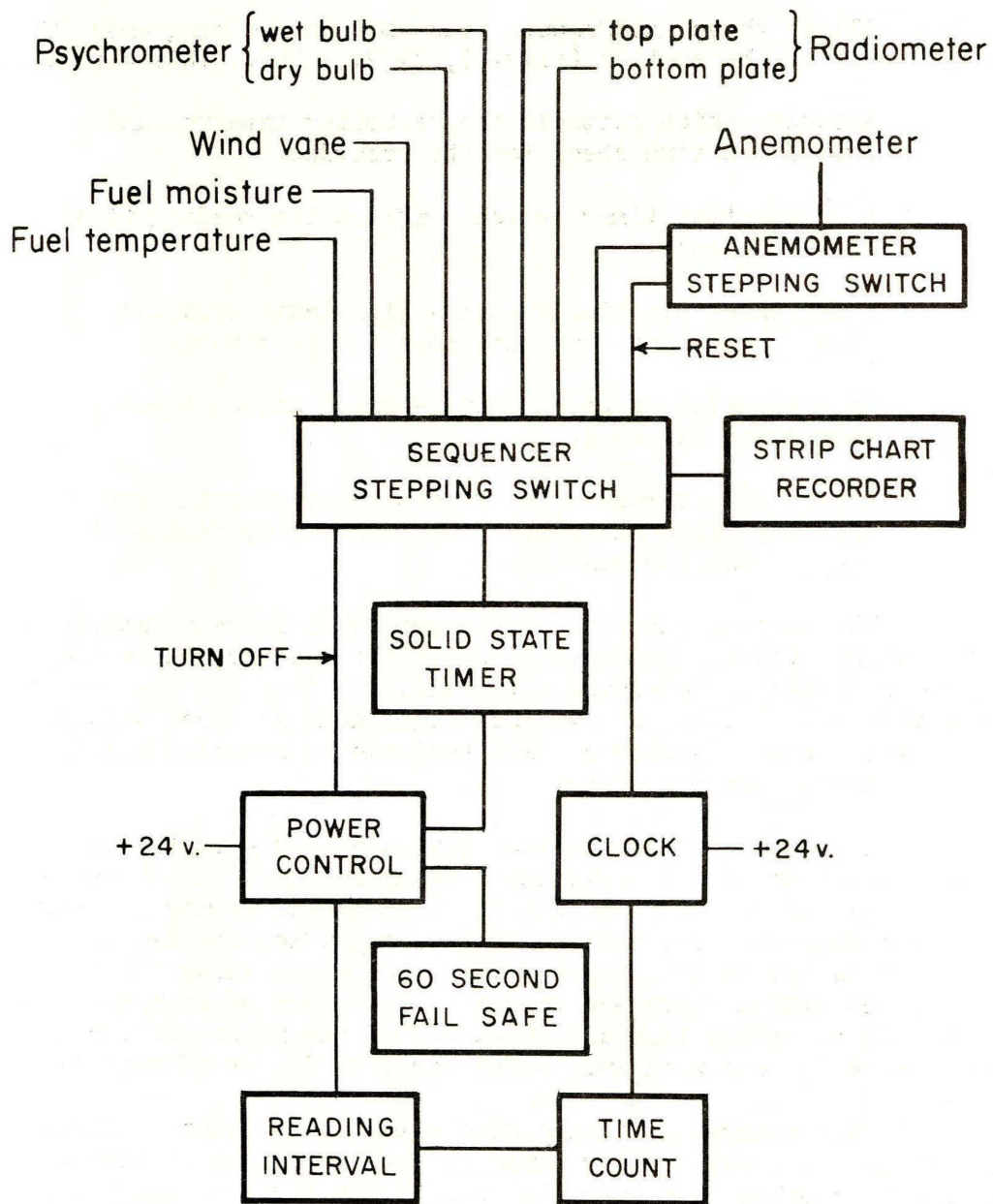


Figure 10.--Block diagram of programmer with sensors and recorder.

All of these instruments feed data to the programmer, the central control unit of the station (figs. 7, 8, 9, & 10). This unit contains:

A clock--which controls the recording interval and provides a time check for the recorder.

A solid-state timer--which controls the reading time of each sensor.

A sequencer stepping switch--which takes readings from sensors and transmits them to the recorder.

An anemometer stepping switch--which accumulates anemometer closures.

A fail safe timer--which resets everything in case anything fails and causes the recorder to remain on longer than one minute.

The control panel on the programmer includes a battery tester, a row of lights (each representing one of the sensors), a switch for selecting 6- or 30-minute recording intervals, a switch for synchronizing the clock with actual time, and various adjustment and test switches. The lights turn on in sequence as each variable is recorded and can be turned off to conserve battery power.

The data are accumulated on a balancing potentiometer recorder we have constructed. It utilizes a standard chart line drive powered by a 24-volt motor. D.C. millivolts from the programmer are converted to A.C. by a chopper. The voltage is then amplified and fed to a servo motor which drives the recording pen. This pen moves along the slide wire until it balances with a reference voltage. The chart paper moves continuously during the recording time and stops during the interval. The supply of paper lasts for one week and is the limiting factor of maintenance.

This automatic station will allow us to gather a great deal of information on local weather patterns with a minimum of time and expense. Its mobility makes it a valuable tool in the study of weather effects on going fires. The next step is to design telemetering equipment which will make it possible to monitor the station by radio, either to collect the data continuously or to make a routine check of the proper functioning of the equipment. With this equipment, the data can also be fed to a central unit where it can be put onto punch cards, magnetic tape, or printed directly.